ESPOL POLYTECHNIC UNIVERSITY
DEPARTMENT OF
MARITIME ENGINEERING AND SCIENCES

THE WORLD SEABORNE TRADE AND TRANSPORT
FACTS AND CHALLENGES

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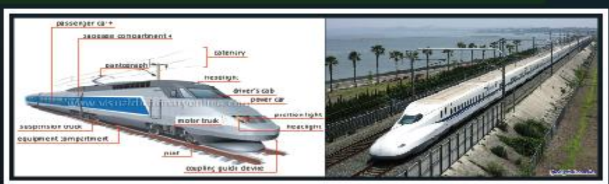
Hugo Tobar Vega

Hugo Tobar Vega is an ESPOL professor, very well convinced of his beliefs; always presenting them in newspaper articles or even books. In one of his recent books, he expressed with high emphasis:" The construction of container ships is growing constantly in size, and now there are plans to build ships to carry 22,000 containers; a situation that will later present new risks and challenges to the busiest ports; because the problems this immense amount of container boxes will present for its handling".

With this big challenge in the years to come for the world economy, Hugo Tobar; since November 2009, started to answer the above statement, writing this new book, in the English language, whose purpose is:

"To present an analysis of a worldwide project, to build special high speed railroads networks connecting ports in the continents all over the world, so to be able to discharge promptly container carrier ships of more than 22,000 containers; to avoid contamination and congestion".

This is good for Hugo Tobar and for ESPOL, the University he belongs to.
Moises Tacle, Ph.D. PRESIDENT



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HUGO TOBAR VEGA
PRELIMINARY EDITION

Preface

- In May 2009, was presented the book "INTERNATIONAL MARITIME TRANSPORT" . In the preface of this book the following statement is defined:

  As time goes by, the construction of container ships is growing constantly in size, there are ships built with a capacity of more of 15,200 container units known as TEUs; and for the year 2010, there are plans to build ships to carry 22,000 containers; a situation that will later present new risks and challenges to the busiest ports, and especially the way the tremendous amount of container boxes will present to its load and unload.

Preface

- This particular situation brings the need to think in a new an innovative solution, these are the facts:

- The projected 22,000 container ship, will have the following characteristics:
  - ✓ Length: 450 meters
  - ✓ Draft: 27 meters
  - ✓ Speed: 25 knots

- This for certain coming situation, calls for an intelligent response because, the world have to answer two fundamental questions:

1. **HOW MANY PORTS ON THE FIVE CONTINENTS WILL BE ABLE TO BERTH THIS GIANT?**

2. **HOW DO WE DISCHARGE AND CHARGE THIS VESSEL WITH THIS AMOUNT OF CONTAINER BOXES TO AND FROM THE PRODUCTION AND CONSUMPTION CENTERS?**

Preface

- Finally, if in the year 2010, there is a project of a 22,000 containers ship, for the year 2050 we have these other questions:

1. **HOW BIG WILL THE BIGGEST CONTAINER SHIP BE?**

2. **HOW WILL THIS SHIP PROPULSION SYSTEM BE?**

3. **IF FOR THE YEAR 2050, THE OIL AND ALL THE FOSSIL FUELS WILL BE COMPLETELY DEPLETED ALL OVER THE WORLD; HOW WE ARE GOING TO PROPEL THESE BIG VESSELS?**

Preface

- This book is integrated by four parts, as follows
  - Part I: The World Seaborne Trade System
  - Part II: The World Seaborne Shipping System
  - Part III: Facts and Challenges
  - Part IV: Special Cases and Findings

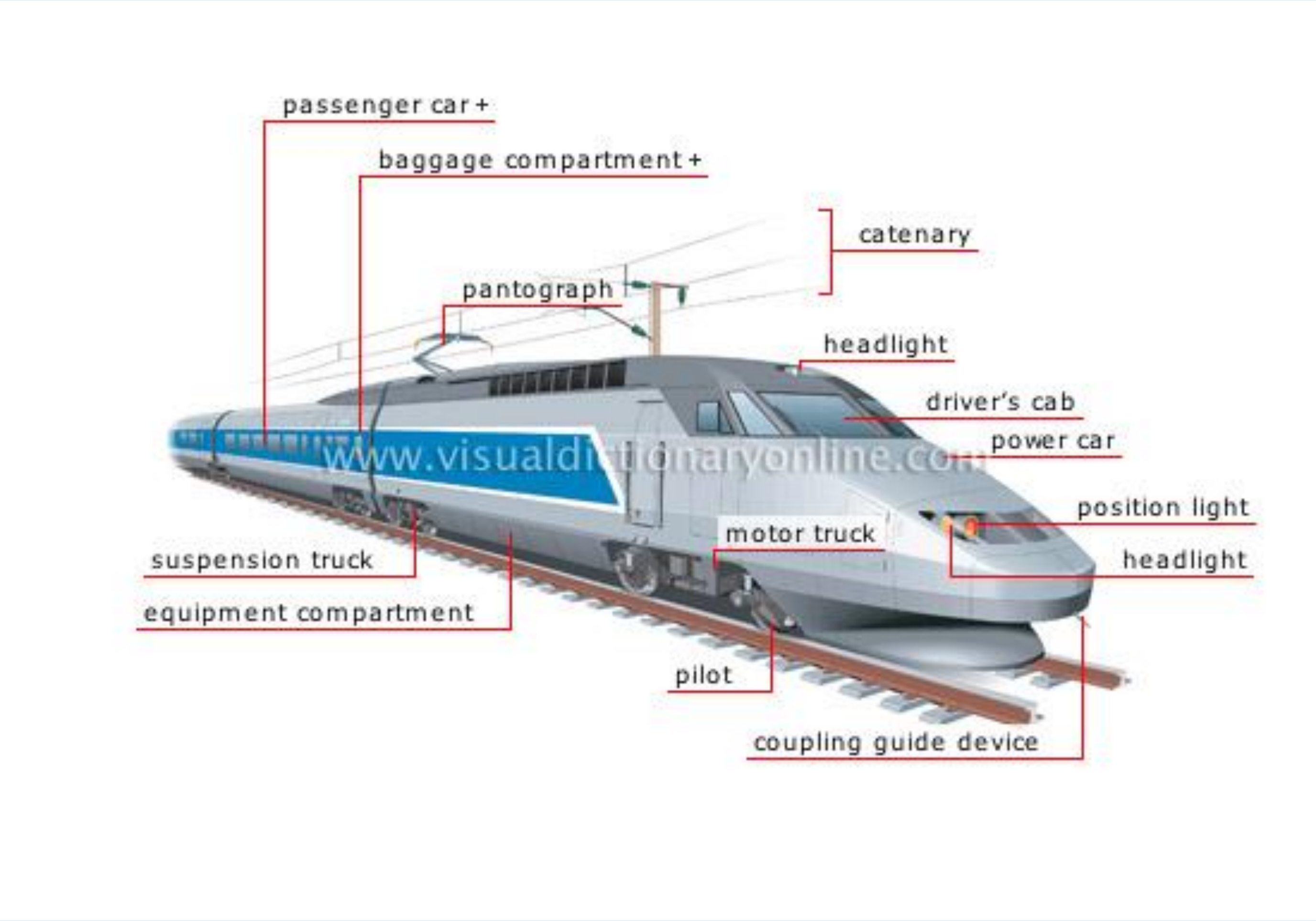
FRONT COVER
Emma Maersk

FRONT COVER
The New Diesel Engine Locomotive

BACK COVER


Trans-Siberian Railway
RUSSIA
9300 km
KAZAKHSTAN
MONGOLIA
CHINA
Vladivostok
1900 km
Shanghai
19 000 km

BACK COVER
High Speed Train Details



BACK COVER
Shinkansen High Speed Train

Part I
THE WORLD SEABORNE TRADE SYSTEM

Maritime transport is divided into three cargo groups:

- The liquid bulk cargo, for the transport of crude oil its products and other liquids.

- The solid bulk cargo, for the transport of minerals and especially those the world most needs, wheat and other grains; essential to feed the whole humanity.

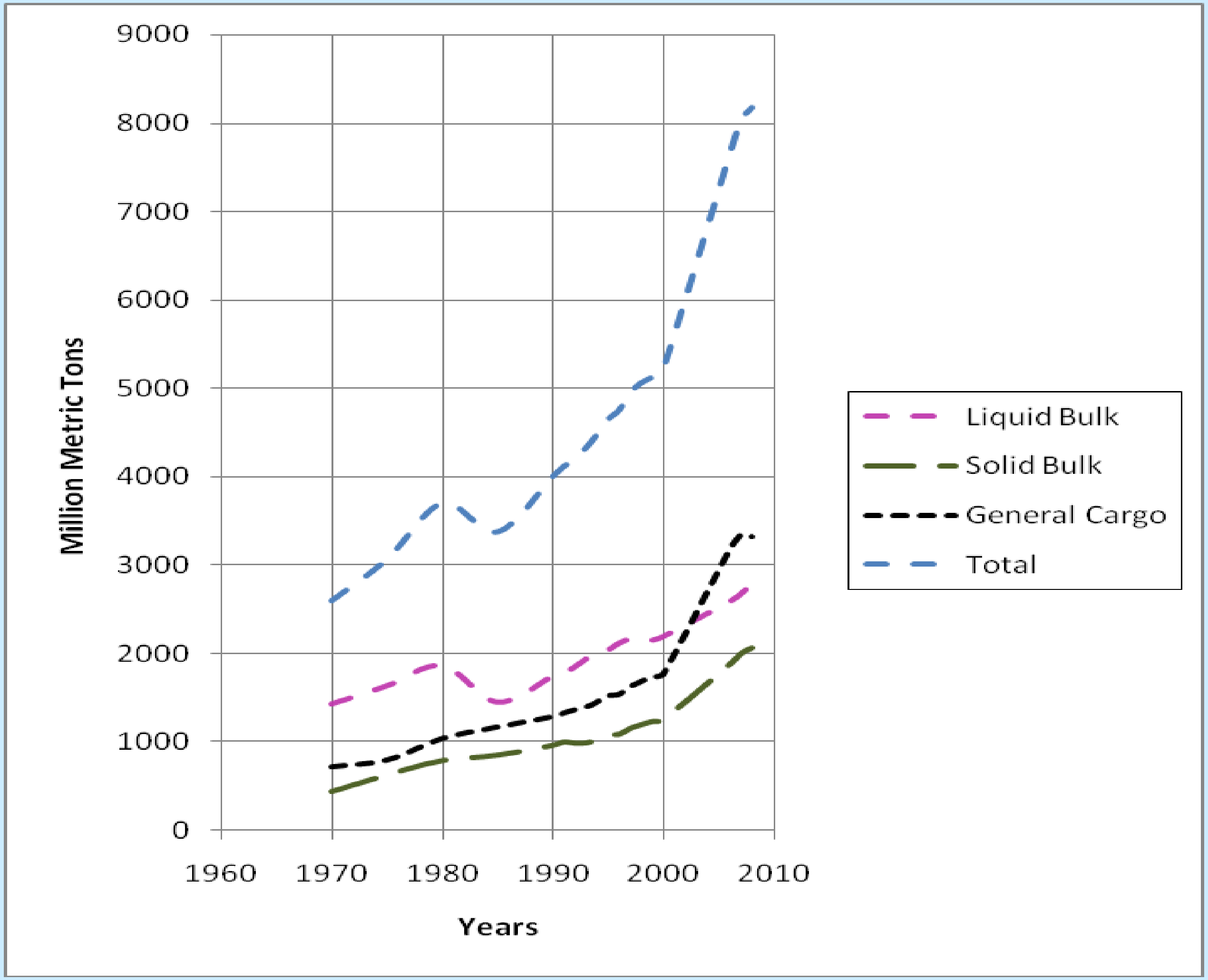
- And the third group is the general cargo, consisting of manufactured products that until the 1960s, were transported loose in the holds of ships; when a wise shipping business executive, generalized the construction and the use of ships built with modular holds to accommodate the containers boxes transported by trucks on the United State of America highways

TYPE OF CARGO
(Millions of Metric Tons)

Year	Liquid Bulk	Solid Bulk	General Cargo	Total
1970	1440	448	717	2605
1975	1644	635	793	3072
1980	1871	796	1037	3704
1985	1459	857	1166	3382
1990	1755	968	1285	4008
1991	1790	1005	1325	4120
1992	1860	990	1364	4220
1993	1945	993	1392	4330
1994	2007	1028	1450	4485
1995	2049	1082	1520	4651
1996	2127	1092	1539	4758
1997	2172	1157	1624	4953
1998	2181	1200	1684	5064
1999	2159	1233	1737	5129
2000	2202	1257	1771	5230
2006	2595	1876	3181	7652
2007	2681	1997	3344	8022
2008	2794	2062	3322	8168

Source: UNCTAD

INTERNATIONAL WORLD TRADE



INTERNATIONAL SEABORNE TRADE TYPE OF PRODUCT (Million Metric Tons)

Year	Crude Oil	Oil Products	Iron Ore	Coal	Grains	General Cargo	Total
1970	1,217	224	235	102	111	676	2.566
1975	1.263	233	292	127	137	995	3.047
1980	1.320	276	314	188	198	1.310	3.606
1985	871	288	321	272	181	1.360	3.293
1990	1.190	336	347	342	192	1.570	3.977
1991	1.247	326	358	369	200	1.610	4.110
1992	1.313	335	334	371	208	1.660	4.221
1993	1.356	358	354	367	194	1.710	4.339
1994	1.403	368	383	383	184	1.785	4.506
1995	1.415	381	402	423	196	1.870	4.687
1996	1.466	404	391	435	193	1.970	4.859
1997	1.519	410	430	460	203	2.070	5.092
1998	1.524	402	417	473	196	2.050	5.062
1999	1.480	410	410	480	210	2.110	5.100
2000	1.608	419	454	523	230	2.200	5.434
2001	1.592	425	452	565	234	2.245	5.513
2002	1.588	414	484	570	245	2.294	5.595
2003	1.650	435	540	610	240	2.365	5.840
2006	1,783	865	733	828	326	3,009	7,545
2007	1,814	891	782	883	348	3,164	7,882
2008	1834	915	815	920	362	3,322	8,168

Source: Shipping Statistics Yearbook 2009 (€ 1200 subscription cost)

Part II
THE WORLD SHIPPING SYSTEM

COMMERCE AND SHIPPING

- The integrated chain of transport has been applied to the international transport, whose primary target is to improve and accelerate the product distribution; and optimize the use of the different transport facilities, reducing the accumulation of cargo inventories.

- But most important reduce the number of inactive facilities and vehicles such as: ships, trucks and railroads by delays at ports; therefore this chain integrated this way is called:

INTERMODALISM OR MULTIMODALISM

Ship Class Economy

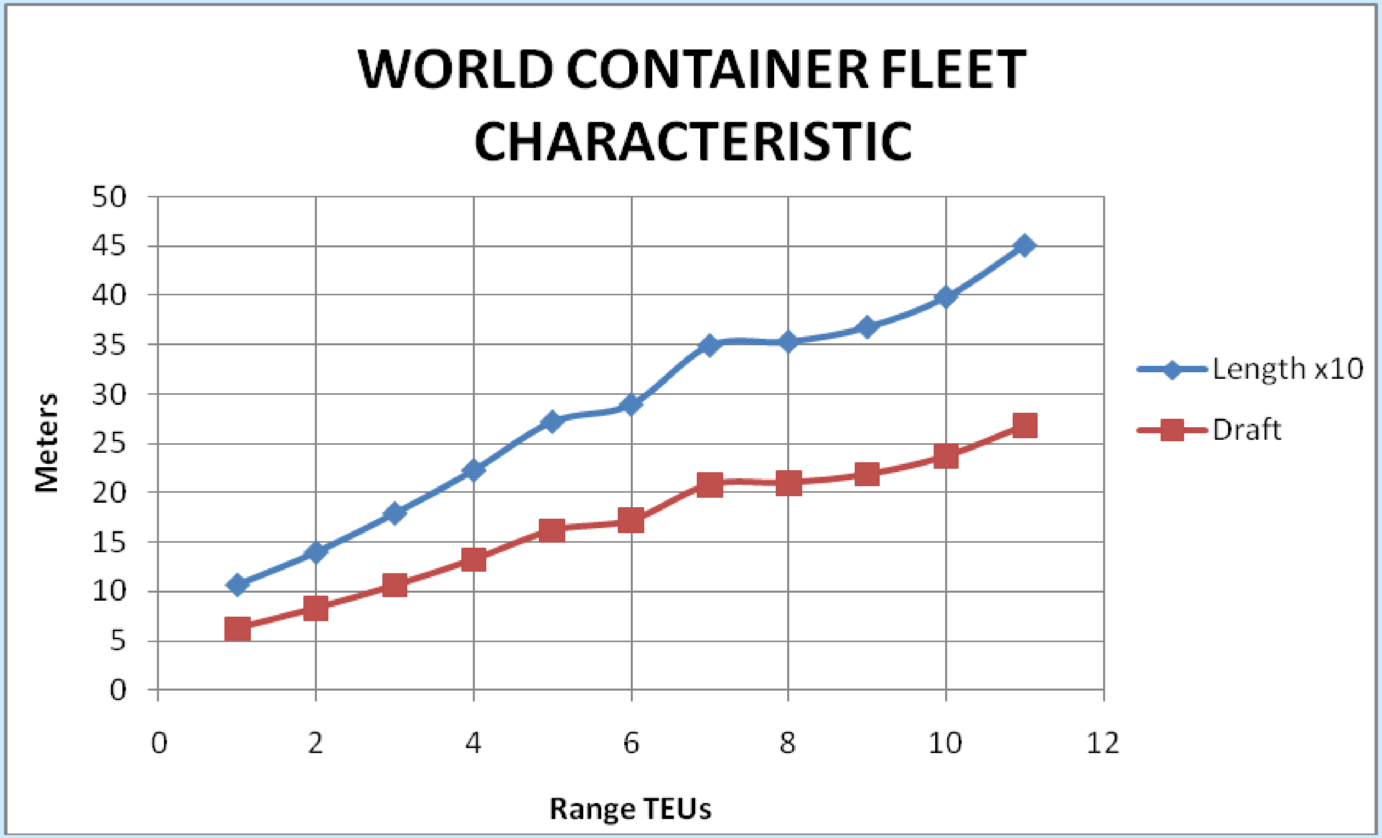
This specialization, generated by the economic aspect, has meant an increase in the size of ships, with a denomination called Worldscale , which is determined by a reason and an index. The Table below, shows this system for the transport of crude oil; there are also scales for other types of transport.

Ship sizes Tons	Worldscale	Índex
50.000	215.0	100.0
70.000	190.0	88.4
150.000	140.0	65.1
255.000	85.0	39.5

CHARACTERISTICS OF THE WORLD CONTAINER FLEET
As January 2010

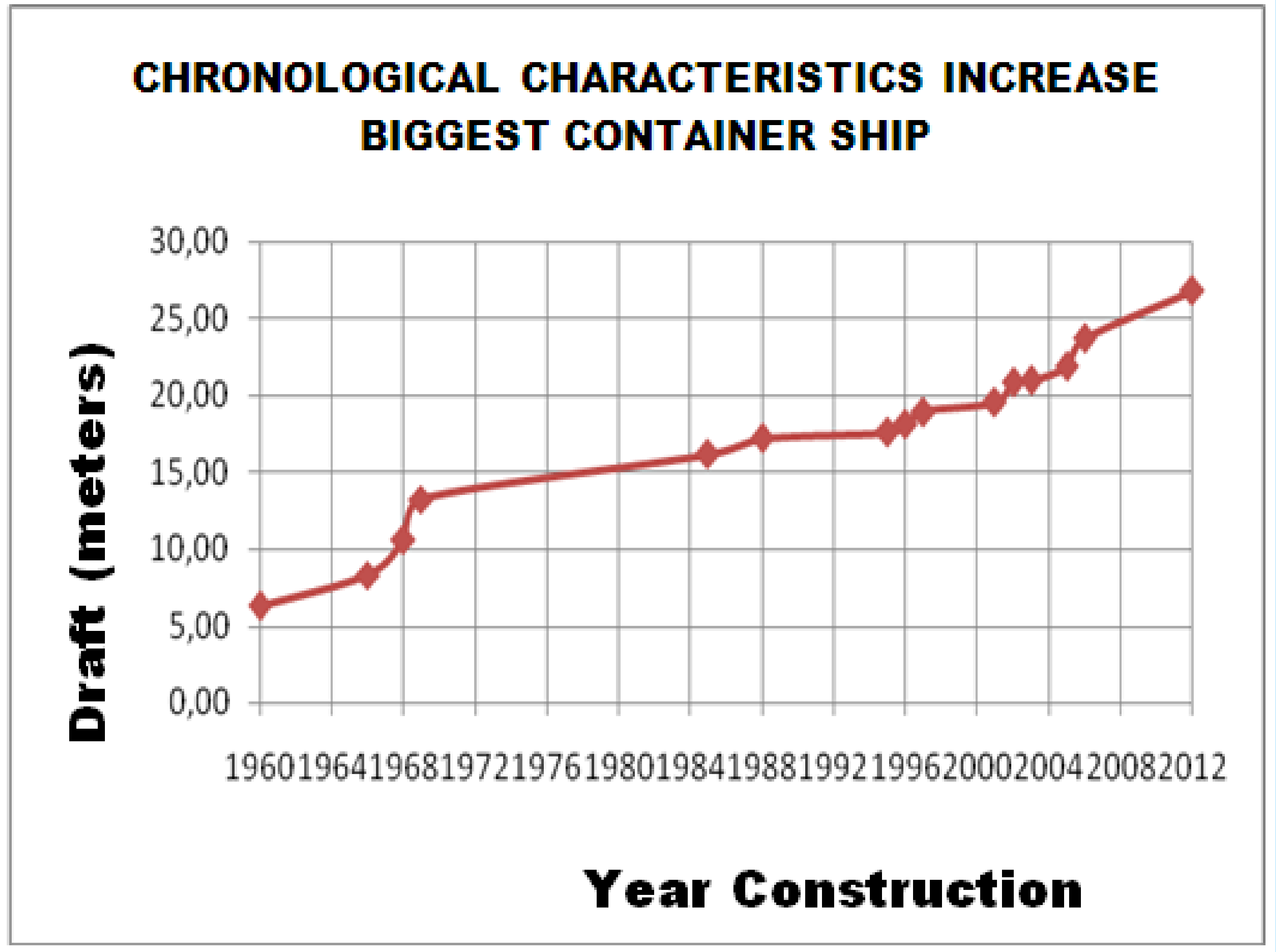
Range TEUs	Class (TEUs)	Capac. TEUs	Length Meters	Draft Meters	Speed Knots
1	Feeder (100-499)	322	106.4	6.24	14.0
2	Feedmax (500-999)	735	139.45	8.29	16.5
3	Handy (1.000-1.999)	1405	178.84	10.60	18.6
4	Sub Pmax (2.000-2.999)	2254	222.38	13.23	20.8
5	Panamax (3.000 +)	3075	271.49	16.16	22.7
6	Post Panamax (4.000 +)	5317	288.90	17.20	24.5
7	Clementine Maersk	9600	348.70	20.80	24.2
8	Axel Maersk	9310	352.60	20.99	25.1
9	Gudrum Maersk	10150	367.30	21.86	25.1
10	Emma Maersk	15200	397.70	23.70	25.3
11	Corea STX (in project)	22000	450.00	26.79	25.1

Source: The Containership Register


WORLD CONTAINER FLEET CHARACTERISTIC
Meters
Range TEUs
Length x10
Draft
0
5
10
15
20
25
30
35
40
45
50
0
2
4
6
8
10
12

CHRONOLOGICAL CHARACTERISTICS INCREASE BIGGEST CONTAINER SHIP

Range	Class (TEUs)	Capacity	Year Construction	Draft
TEUs		TEUs		Meters
1	Feeder (100-499)	322	1960	6,24
2	Feedmax (500-999)	735	1966	8,29
3	Handy (1.000-1.999)	1405	1968	10,60
4	Sub Panamax (2.000-2.999)	2254	1969	13,23
5	Panamax (3.000 +)	3075	1985	16,16
6	Post Panamax (4,000 +)	4625	1988	17,20
7	Post Panamax Plus1 (5,000 +)	5225	1995	17,58
8	Post Panamax Pus 2 (6,000 +)	6375	1996	18,13
9	Post Panamax Pus 3 (7,000 +)	7250	1997	18,92
10	Post Panamax Pus 4 (8,000 +)	8050	2001	19,50
11	P. Pan Plus 5 (Clement Maersk)	9600	2002	20,80
12	P. Pan Plus 5 (Axel Maersk)	9310	2003	20,99
13	Suez Max (Gudrum Maersk)	10150	2005	21,86
14	Post Suez Max (Emma Maersk)	15200	2006	23,70
15	Corea STX	22000	2012	26,79



CHRONOLOGICAL CHARACTERISTICS INCREASE
BIGGEST CONTAINER SHIP
Draft (meters)
30,00
25,00
20,00
15,00
10,00
5,00
0,00
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
Year Construction

From the data shown on the table above, during the period of 52 years from 1960 to 2012, the following facts are produced:

1. **The maximum draft of the biggest container carrier ship built, increases from 6.24 to 26.79 meters, at a rate of 0.40 meters per year.**

2. **The maximum capacity of the biggest container ship built, increases from 322 to 22,000 containers, a rate of 417 per year.**

These findings give us a real indication of what the world can expect for the main question presented in this book of:

WHAT DO WE EXPECT FOR THE YEAR 2050 OF THE WORLD SHIPPING SYSTEM?.

Design Parameters of Largest Container Ships

Design Parameters	Malacca-max;	Suez-max;	Sovereign Maersk
Length (m)	400.00	400.00	348.00
Breadth (m)	60.00	50.00	42.80
Draft (m)	21.00	17.04	14.00
Depth (m)	35.00	30.00	24.10
Displacement (tons)	313,371	212,194	142,500
Deadweight (tons)	243,600	157,935	105,000
TEU capacity	18,154	11,989	8,400
Service speed (kn)	25.00	25.00	25.00
Engine power (kW)	116,588	91,537	61,000

PROPULSION TRENDS IN BIG CONTAINER CARRIERS

- Container ships of up to 22,000 Teu, may be expected in the future as soon as 2012. For such very large vessels , the propulsion requirement may be up 100 MW/136,000 Brake Horse Power (bhp), when operating at 25 knots.

- Single-screw vessels are the cheapest and most efficient solution compared with a twin screw solution.

- A great deal of analysis has been made, dealing with container vessels built over the last five years, in particular using the latest MAN B&W two-stroke engine.

The Actual Biggest Container Ship Propulsion System

- The Emma Maersk transports containers across the Pacific Ocean in only five days, at a cruise speed of 31 knots.

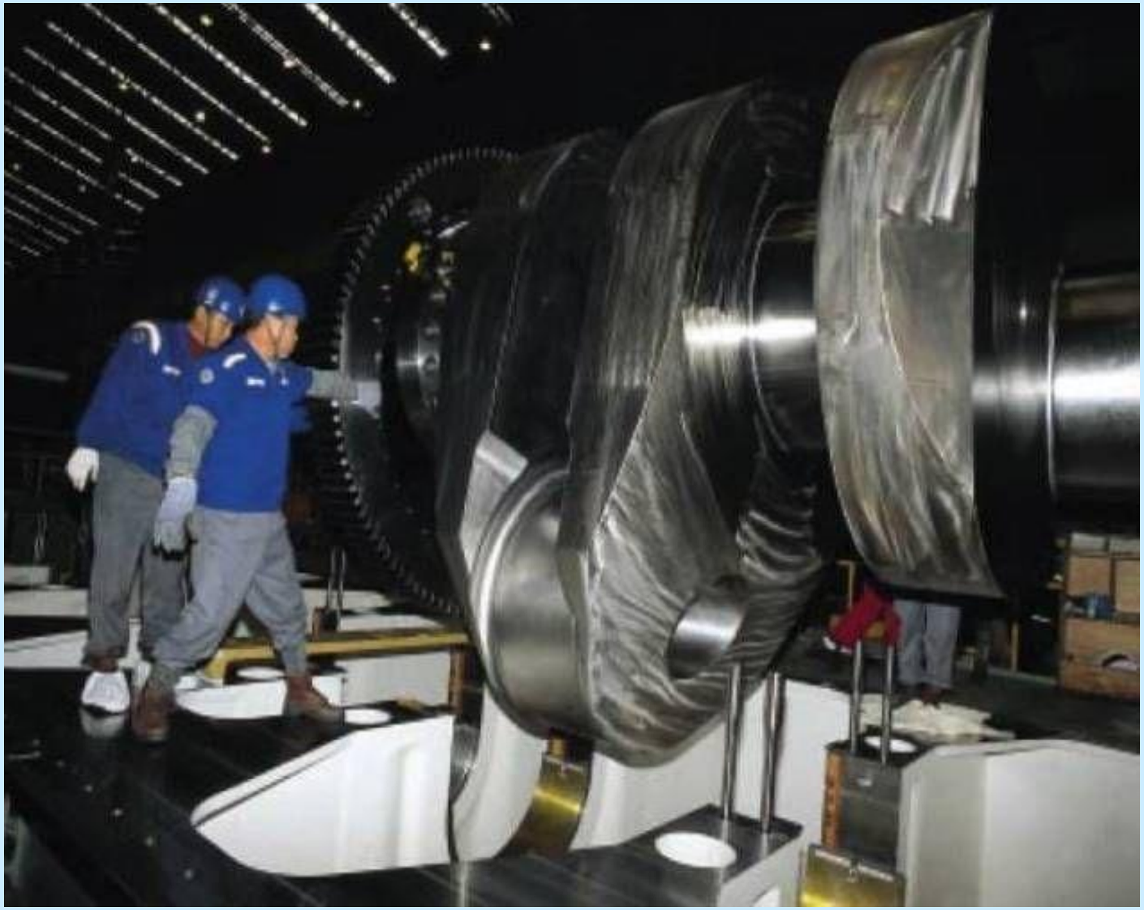
- This vessel is strictly for the Trans Pacific service, from China to California.

- Was built in five sections, the navigation bridge is higher than a 10-story building and has 11 cargo crane rigs that can operate at the same time.

- Length: 397 meters; Draft: 23.7 meters
- Cargo capacity: 123,200 tons, 15,200 Teu
- Propulsion: 14 cylinders in line diesel engine, 110,000 BHP
- Crew: 13 people
- Construction cost: US$145´000,000
- First trip: September 8, 2006

Emma Maersk Crankshaft

and Operators



Nuclear Power the Future Propulsion System

- Nuclear power has been used for propulsion in submarines and aircraft carriers. For submarines to attain a great fuel autonomy (even years) and for aircraft carriers, because fossil fuels engines were too big and cumbersome.

- On December 2009, the President of the Chinese shipping line **COSCO**, presented a proposal to use nuclear power onboard merchant ships. In this occasion he said:

  "*The decision to push ahead with super slow steaming, was in part environmental; using nuclear power onboard merchant ships is a further green initiative. As they are already onboard submarines, why not cargo ships*?"

- COSCO is in talks with the Chinese national nuclear authorities, about this new idea.

Characteristic & Conditions

- Initial costs are six times higher ($900 million versus 150 million)
- Three nuclear ships could do the work of 4 regular ships and operational costs would be lower.
- A reasonable timeline for nuclear commercial shipping is in the 10-15 year timeframe (2020?). The characteristics of this vessel are:

Capacity 15,000 TEU (like the Emma Maersk)
Length: 405 m ;Beam: 60 m ;Draft: 15.5 m
Speed: 32 knots; Power: 150 Mw (200,000 SHP); Propellers: 2

Economic Findings

1. Assumes Nuclear @ $2500 / kW
2. Assumes Diesel @ $800 / kW
3. Assumes Plant Life 40 Years
4. Assumes Interest Rate 10%

Special Condition This propulsion system is possible only for ships of about 10,000 Teus and up, because the size limitations of a nuclear power plant.

PORT INTERMODAL RAIL TRANSPORT

- Intermodal freight transport, involves the transportation of freight in an intermodal container or vehicle, using multiple modes of transportation (rail, ship, and truck); without any handling of the freight itself when changing modes. This method reduces: cargo handling, damages, losses; and **freight is transported faster**.

Reduced costs versus over road trucking are the key benefit for intercontinental use.

- In the U.S. such containers, known as "lift vans”, were in use from as early as 1911. Later these vans transported by trucks on highways, adopted the 8x81/2x 20 measurements; and were directly put aboard especially built ships to transport merchandizes all over the oceans of the world.

The illustration that follows, show an intermodal train carrying both shipping containers and highway semi-trailers.

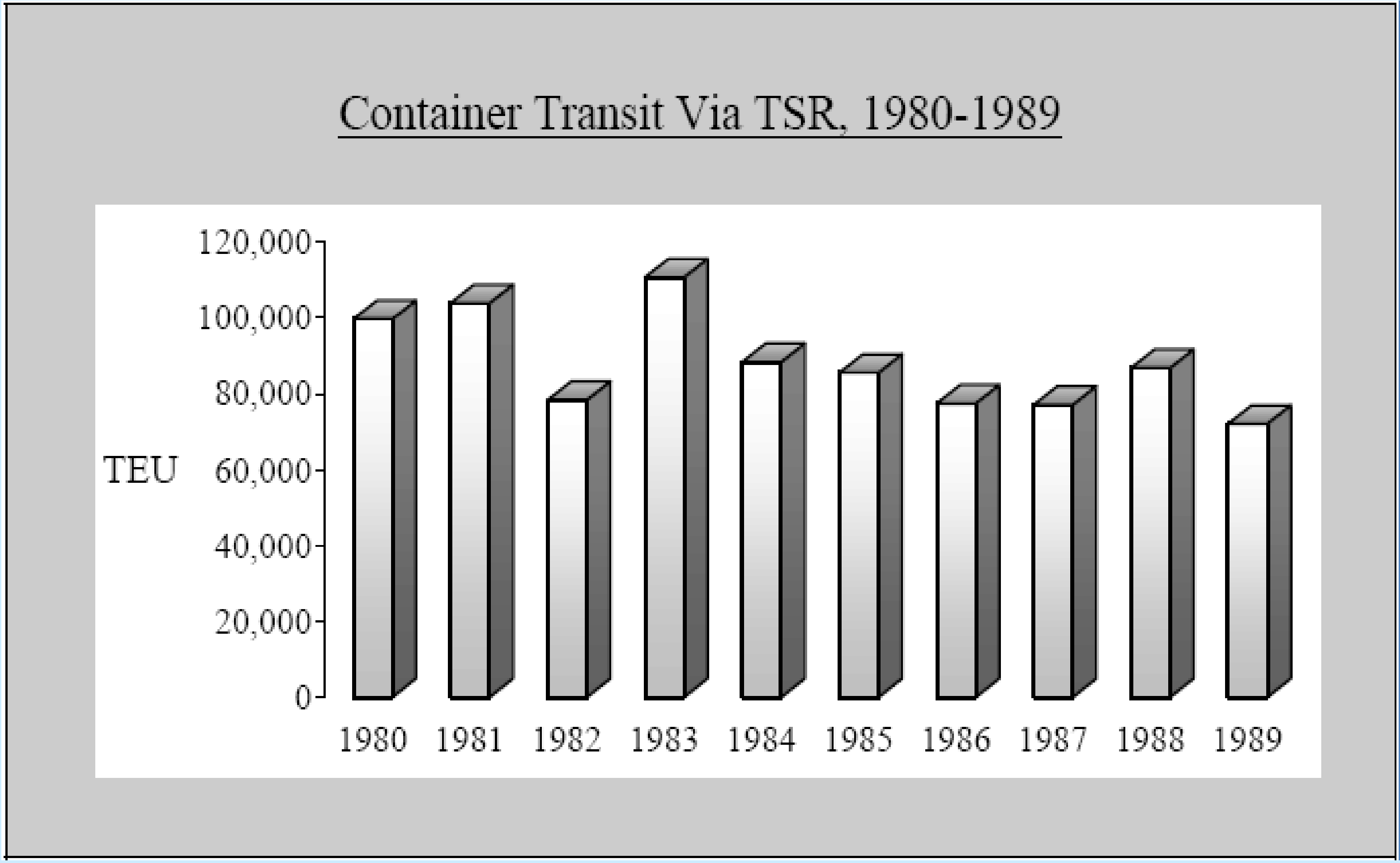
Intermodal Railroad Networks
The Trans Siberian Railway System

- This is the most extensive and important intermodal railroad network in the world. The illustration of this network considered one of the marvels of the world, has been the inspiration to realize this investigation and analysis of this work; “**to use high speed trains for the intermodal transportation on land, the immense quantities of containers carried these days by very big container carrier ships and of the future”.**

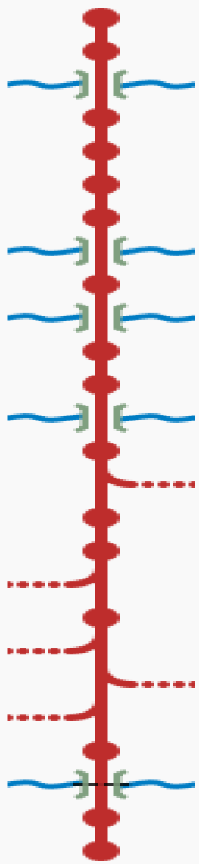
- The Trans-Siberian is a major freight artery offering a fully developed container service across Eurasia from Berlin to Beijing, with links to major cities in Europe, including Helsinki, Kaliningrad, Warsaw, Minsk, Kiev, St-Petersburg, Smolensk and Yekaterinburg. And in addition to Russian stations in Siberia itself, the Trans-Sib also has connections to Astana in Kazakhstan, Ulaanbaatar in Mongolia, Beijing in China, Pyongyang in North Korea and Seoul and Pusan in South Korea.

- To attract freight to the Trans-Siberian route the International Coordinating Council on Trans-Siberian Transportation was formed.

Trans-Siberian Railway


Container Transit Via TSR, 1980-1989
TEU
120,000
100,000
80,000
60,000
40,000
20,000
0
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989

Stations Along The Trans-Siberian Railroad Network



km	Station	
0	Yaroslavsky Terminal, Moscow	[show]
284	Yaroslavl	
289	*Volga River*	[show]
957	Kirov	[show]
1436	Perm	[show]
1816	Yekaterinburg	[show]
2144	Tyumen	[show]
2706	*Irtysh River*	
2712	Omsk	[show]
3332	*Ob River*	
3335	Novosibirsk	[show]
4098	Krasnoyarsk	
4101	*Yenisei River*	[show]
4516	Taishet	
4520	Baikal Amur Mainline junction	[show]
5185	Irkutsk	[show]
5642	Ulan Ude	
5655	Trans-Mongolian line junction	[show]
6199	Chita	[show]
6312	Trans-Manchurian line junction	[show]
7273	*line to BAM*	[show]
7875	*line to Blagoveshchensk*	[show]
8351	Birobidzhan	[show]
8515	*Amur* J.A. Oblast - Khabarovsk Krai border	
8521	Khabarovsk	[show]
9289	Vladivostok	

Trans-Siberian Railroads Networks Operators

- China Shipping Container Lines
- ZHL Trans Professional
- NWS Holdings
- Trans Container and China Railway Container Transport

Conclusions

From the start the Siberian transit transport route was intended in addition to Russia own transport needs, for goods traffic between West Europe and Japan. Since then, connections have been made with Hong Kong and the Philippines. In the future connections via Siberia may be made with Taiwan, South Korea and other East Asian countries and Australia. Thus the international significance of the Trans-Siberian railway in trade between the Far East and Europe will increase considerably.

WITH THE INCREASE IN SIZES OF CONTAINER SHIPS, THIS RAILROAD NETWORK WILL BE THE MOST IMPORTANT ROAD OF MULTIMODAL TRANSPORT FROM THE HIGH PRODUCTIVE ASIAN NATIONS TO: ALL EUROPE, THE MIDDLE EAST AND THE SOUTH ASIAN COUNTRIES.

HIGH SPEED RAILROAD SYSTEMS

The Italian ETR 200 in 1939, was the first high speed service train. It achieved the world mean speed record in 1939 of 203 kilometers per hour (km/h) near Milan in Italy. The picture that follow show this train traveling with passengers approaching Milan.

Definition of High Speed Trains

- There are a number of different definitions for high-speed rail, and there is no single standard.
- European Community Directive 96/58, defines high-speed rail as systems of rolling stock and infrastructure which regularly operate at or above 250 km/h on new tracks, or 200 km/h on existing tracks.
- In the United States high-speed rail is defined as having a speed above 110 mph (180 km/h) by the United States Federal Railroad Administration
- In Japan high speed Shinkansen lines use standard gauge track rather than narrow gauge track used on other Japanese lines. These travel at speeds in excess of 260 km/h without at-grade crossings.
- In China there are two grades of high speed lines. Firstly slower lines that run at speeds of between 200 and 250 km/h and have freight as well as passenger trains. Secondly, passenger dedicated high speed rail lines operate at top speeds of up to 350 km/h.

Power Source

- Travel by rail becomes more competitive in areas of higher population density or where gasoline is expensive, because conventional trains are more fuel efficient than cars and other forms of mass transit. Very few high-speed trains consume diesel or other fossil fuels but the power stations that provide electric trains with power can consume fossil fuels, or use nuclear plants.

- In Japan and France, where the most extensive high speed rail networks exist, a large proportion of electricity comes from nuclear power. Even using electricity generated from coal or oil, trains are more fuel efficient than the typical automobile because of economies of scale in generator technology.

Technology and Costs

- France's TGV technology has been adapted for use in a number of different countries.

- Much of the technology behind high-speed rail is an improved application of mature standard gauge rail technology **using overhead electrification.** By building a new rail infrastructure with 20th century engineering, including elimination of constrictions such as roadway at-grade (level) crossings, frequent stops, a succession of curves and reverse curves, and not sharing the right-of-way with freight or slower passenger trains, higher speeds (250–320 km/h) are maintained.

Technology and Costs

- Total cost of High Speed Rail systems is generally lower than the total costs of competing alternatives (new highway or air capacity). Japanese systems are often more expensive than their counterparts but more comprehensive because they have their own dedicated elevated guide way, no traffic crossings, and disaster monitoring systems. The high Japanese system's cost is related to the boring of tunnels through mountains, as in Taiwan.

- Recent advances in wheeled trains in the last few decades have pushed the speed limits past 400 km/h, among the advances being tilting trainsets, aerodynamic designs (to reduce drag, lift, and noise), air brakes, regenerative braking, stronger engines, dynamic weight shifting, etc..

Magnetic Levitation

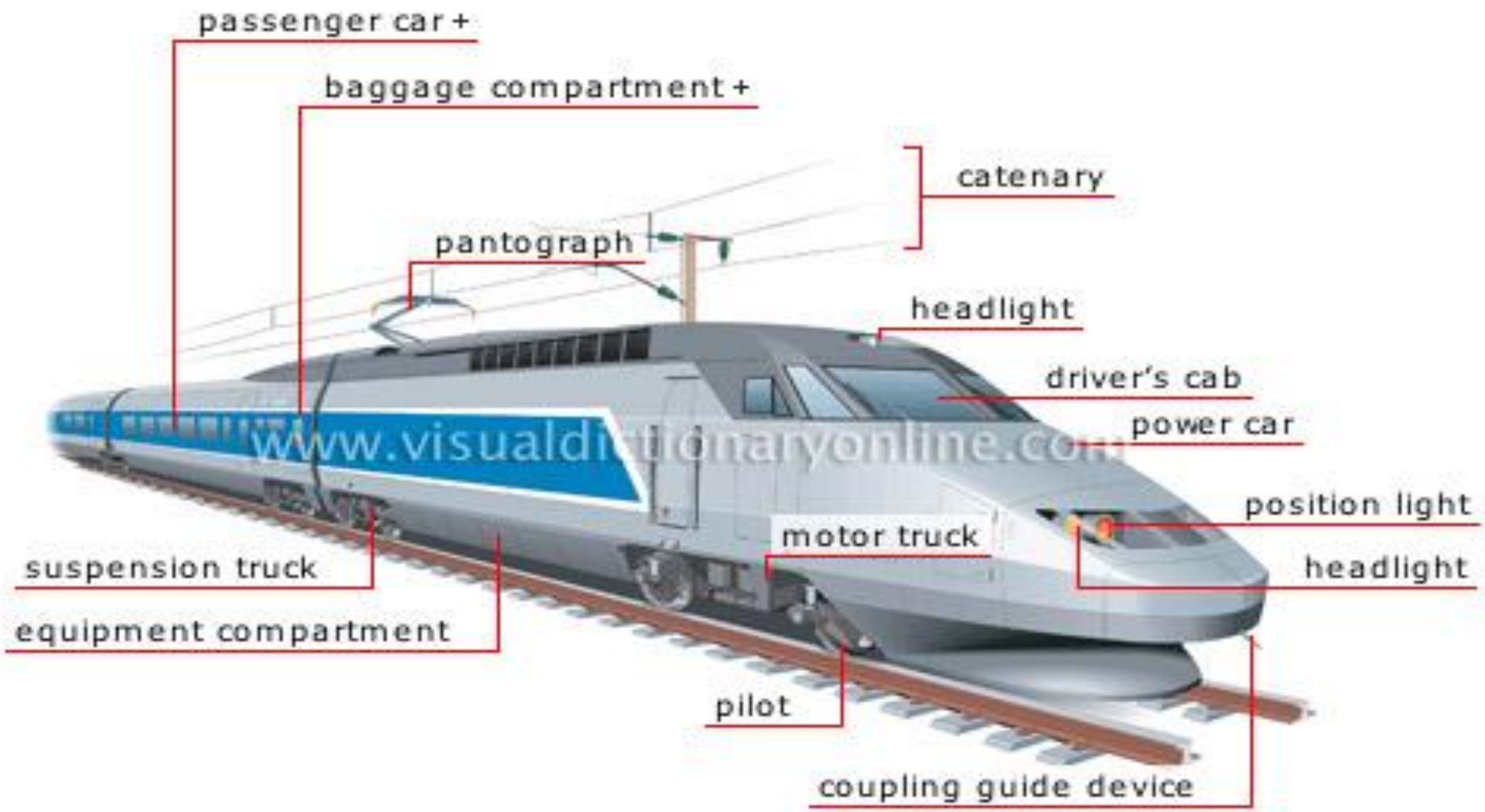
- **Maglev, or magnetic levitation**, is a system that suspends guides and propels trains, using magnetic levitation from a very large number of magnets for lift and propulsion. This method has the potential to be faster, quieter and smoother than wheeled systems. The power needed for levitation is usually not a particularly large percentage of the overall consumption; most of the power used is needed to overcome air drag, as with any other high speed train.

- The highest recorded speed of a Maglev train is 581 km/h, achieved in Japan in 2003.

- The first commercial Maglev "people-mover" was opened in 1984 in Birmingham, England. It operated between Birmingham Airport and Birmingham Railway Station, running at speeds up to 42 km/h; the system was closed in 1995 due to design problems.

Magnetic Levitation Train in Germany

The Typical High Speed Train Components



Recent Projects

South Africa

The Gautrain, Africa's first high-speed rail line, was launched on June 8, 2010 in South Africa three days before the opening match of the 2010 football World Cup.

Brazil

The Brazilian government envisages three additional high-speed rail lines as part of the latest set of ambitious infrastructure plans outlined at the end of March 2010 by President Luiz da Silva.

China

On may 2010, the government of China announced that the country is spending mountains of money on “China’s Cut-Throat Railway Revolution” to expand its country's high-speed railway network and manufacture the world's fastest trains.

United States of America

Japan to give loans for US high-speed rail bids was announced on April 27, 2010. Japan will allow state loans for bids to build high-speed train lines in the U.S. to boost the nation’s railroad suppliers as they compete against Chinese and European rivals.

And Finally

After this presentation, I hope that in the near or distant future; time will come for high speed intermodal railroad networks in all the continents of the world, as an answer to the very big nuclear propelled container ships to come.

This is my wish and hope

Thanks for your time and attention

Hugo Tobar Vega